academicJournals

Vol. 11(22), pp. 654-664, 28 November, 2017
DOI: 10.5897/AJBM2017.8405
Article Number: C2F91D766690
ISSN 1993-8233

http://www.academicjournals.org/AJBM

African Journal of Business Management

Full Length Research Paper

Ambidexterity between operation and innovation: A stochastic queuing model

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Received 7 August, 2017; Accepted 14 September, 2017

The notion of productivities dilemma indicates that organizations need to balance the tension between operation and innovation to ensure both short term performances and long term adaptability. Ambidexterity as a solution to productivity dilemma has lack analysis on micro-level ambidexterity. In this paper, a group process view and a stochastic queuing model were adopted to study the optimal time arrangement between operation and innovation. Our research reveals that time division between operation and innovation will have negative impact on operational efficiency; however, such negative impact can be managed through certain rhythm of time division between operation and innovation. Specifically, arranging frequent innovative activities is optimal to the situation between operation and exploitive innovation; whereas arranging infrequent innovative activities is optimal to the situation between operation and explorative innovation. Further, our result also may help managers to identify the timing to accelerate or decelerate the innovative activities while keeping the operational efficiency in an optimal state.

Key words: Dilemma, ambidexterity, operational efficiency, group process, process variability.

INTRODUCTION

Overtime business environment has become increasingly unstable, more chaotic and full of relentless change (Eisenhardt and Brown, 1998). Recent empirical research indicates that many firms have positioned themselves in more dynamic environments than ever, with continuous changes such as technical innovation, globalized competition and entrepreneurial action that impose heavy pressure on firms' daily operations and innovation (Wiggins and Ruefli, 2005; Schreyögg and Sydow, 2010). The fact that firms need to balance conflictions rising from daily operations performance while preparing for future innovation shocks has become a fundamental assertion in operation, strategic management and organization theory literature (Venkatraman et al., 2007). Abernathy's (1978) research summarizes such paradox as the firm focuses on productivity gains inhibited its

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JEL Classification: L16 O33.

flexibility and ability to innovate has inspired decades of research and debate. It has come into a general consensus in the management research that a firm's survival in the long term can only be secured by being simultaneously efficient and innovative (Abernathy, 1978; Hayes and Abernathy, 1980; Benner and Tushman, 2003; Adler et al., 1999).

Prior literature has emphasized ambidextrous organization as the primary solution to such dilemma (Tushman and O'Reilly, 1996; Gibson and Birkinshaw, 2004; Adler et al., 2009); however, there has been a wide debate on how ambidextrous organization can be achieved. On an organizational level, prior literature generally offers structural solutions such as structural ambidexterity and punctuated equilibrium. These methods emphasize that the organizations need to separate efficiency oriented operations such as exploitation from adaption oriented innovations by dividing organizations' structure or temporal focuses. Some later literature shift focus to a micro-level such as business units and individuals to facilitate adaptation of entire system and avoid coordination problems generated by structural solutions. Such literature proposes continuous change and contextual ambidexterity to facilitate business unit level and individual level ambidexterity. Continuous change literature offers that organizational units should rhythmically switch their time and attention between efficiency oriented and innovation oriented activities, whereas contextual ambidexterity emphasizes that managers only provide supportive contexts and do not intervene individuals in the business unit to divide their time between different activities. Although, the aforementioned literature has reported various antecedents and outcomes on ambidexterity issue, empirical evidences reported by later researches are still inconsistent in regard to ambidexterity-performance linkage. Some literature finds positive link between organizational ambidexterity and firm performance (Gibson and Birkinshaw, 2004; He and Wong, 2004). Others find no direct effect between ambidexterity and performance (Bierly and Daly, 2007) or curvilinear relation (Yang and Atuahene-Gima, 2007). Lin et al. (2007) even finds negative relation between ambidextrous activities and firm performance. In reconsidering such gap in empirical evidences and previous theoretical development, it was observed that although major prior research has emphasized the importance of organizational process and system (Adler et al., 1999; Gibson and Birkinshaw, 2004), little attention has been paid to the question of how different potential arrangement on operational process may contribute to the inconsistence between ambidexterity and performance.

As in reality, organizations in multiple situations tend to assign both operational and innovative tasks to individuals and business units, such as for the consideration of advancing technological advantage, improvement of marketing and sales results or major shift of strategic directions for sustaining competitive advantage and performances. However, individuals and business units when assigned with such tasks usually face difficulty of splitting time, resources and attentions between different types of tasks and such difficulty usually results in lack of focus and reduce the operational efficiency. In this paper, a process view was taken to delineate such difficult situations. Parting from traditional view only emphasize the culture and behavior context in solving the operation-innovation tension; the tension between operation and innovation within an integrated system was considered and investigated into the question how ambidextrous individual's time arrangement between operational and innovative activities impact efficiency of work process, and what is the best way for individuals to arrange their time between operation and innovation? Our synthesis of prior literature lead us to nuanced view that time division between operation and innovation needs to consider the process between operation and different types of innovation (e.g. exploitive innovation and explorative innovation). Different types of innovation were argued to have different impact on efficiency of individual work flow and group level process. Prior literature observed that different innovative activities generally bring variability to individuals' work flow and needs tradeoff for work operational efficiency (Benner and Tushman, 2003), however, with different magnitudes. Exploitive innovation as its adjacency to existing knowledge, brings relatively low level of variability to individual's work flow, whereas explorative innovation is generally distant from existing knowledge, and brings high level of variability to individual's work flow. Individuals' arrangement of time between operation and different types of innovations in an operational context was treated as a group process and a stochastic queuing model was adopted to capture the process and result of different time arrangements. Our research result shows that for time division between operation and exploitive activities, individuals need to adopt a rhythm of switching with high frequencies, whereas for time division between operation and explorative activities, individuals need to adopt a rhythm of switching with low frequencies.

To explain our theory and argument, this paper proceeds as follows. First, a synthesis of ambidextrous organization literature and relative theories regarding individual ambidexterity was made. The major shortcoming in existing literature on individual ambidexterity was identified and our theoretical argument with a process view of individual ambidextrous work flow was presented. The second step is to take simulation approach to understand the dynamics of switching of attentions for ambidextrous work process. By adopting a stochastic queuing system (Kingman, 1961) and a group process view, we wish to delineate the variability that different innovative activities bring about into the micro-level process and the tradeoff between work flow variability and efficiency. The third part is modeling, simulation result discussion, and managerial implication. The end of this paper concludes the research.

THEORETICAL BACKGROUND

Abernathy (1978) suggests that the focus on productivity gains within a firm will consequently restrain its flexibility and ability to innovate. In his case of automobile industry, the constant pursuit of economic efficiency has a correlation with a firm's economic decline. Gupta et al. (2006) assert balancing efficiency and exploitation with innovation and exploration are still battering issue for nowadays organizations. In answering the question of how to achieve ambidexterity, literature has reported various antecedents and associated outcomes of ambidexterity.

On an organizational level, earlier researches have emphasizes structural antecedents and specialized units that focusing on either exploitation or exploration would help organizations to achieve ambidexterity (Duncan, 1976). The specialized units are spatially separated, which ensures each of such units can be configured to the requirements of their diversified tasks. Alternatively, later ambidexterity literature suggests punctuated equilibrium methods that emphasizes organizations to vacillate between centralized structures and decentralized structures to facilitate ambidexterity (Nickerson and Zenger, 2002; Siggelkow and Levinthal, 2003; Venkatraman et al., 2007). On a micro level, structural antecedents' literature also offers ample solutions such as the use of parallel structures (Bushe and Shani, 1991; McDonough and Leifer, 1983; Stein and Kanter, 1980; Zand, 1974). The parallel structure refers to business units switching back and forth from formal structures to semi-structures solutions. The formal structure aims at executing efficiency oriented operational tasks, whereas semi-structures aim at injecting flexibility into operational process with innovative tasks (Brown and Eisenhardt, 1997). Some other literature focusing on micro-level ambidexterity proposed contextual antecedents that emphasize business unit managers only provide a supportive context that uses systems, processes and beliefs to encourage individuals in the business units' engagement in innovative activities (Gibson and Birkinshaw, 2004). Later researches provide insights on different impact of coordination mechanisms on exploration and exploitation activities on ambidexterity. For example, the presence of formalization and top-down knowledge flows will enhance exploitation, whereas decentralization of decision making and bottom-up knowledge flows are to enhance exploration (Benner and Tushman, 2003; Jansen et al., 2006; Mom et al., 2007; Cardinal, 2001). More contextual factors were highlighted by later research such as how human resource management practices could help implement ambidexterity (Kang and Snell, 2000).

Micro-level analysis such as individual level or team/group level analysis has been limited and advocated for further theorization and more empirical research (Turner et al., 2013; Mom et al., 2007; Bonesso et al., 2014; Raisch and Birkinshaw, 2008). Extant literature represented by Mom et al. (2007, 2009) and Bonesso et al. (2014) has primarily focused on cognitive and behavioral factors. Mom et al. (2007, 2009) give a detailed account of managers' ambidextrous behavior and show not only firm level ambidexterity can be pursued but also individual level ambidexterity can be managed. Bonesso et al. (2014) further discuss the complex relation between individual perception and behavior of ambidexterity in working context and show how it is related to individual characteristics.

Prior ambidexterity literature builds on March (1991) learning activities distinction between exploitation and exploration in organizational learning. Such distinction captures the organizational level dichotomy in achieving balance between short term efficiency and long term growth in changing task environment. However, the micro-level ambidexterity exhibits much more complexity when individuals and business units are trying to operationalize the proposed solutions. Benner and Tushmen (2003) noted that such confliction not only creates tension between operation and innovation, but also between different types of innovation. Later strategy literature captures this phenomenon by distinguishing exploitation into two dimensions: the repetitive, incremental exploitation and exploration, and respectively ask the relationships between these three elements. Operational literature such as Kortmann et al. (2014) further conceptualizes the relationships into two levels of ambidexterity: the operational ambidexterity and innovative ambidexterity.

Prior literature has also emphasized that innovations concern with distinct categorization, because different types of innovation have contrasting determinants and organizational effects (Morone, 1993; Tushman and Smith, 2002). As a general consensus, innovations can be considered generally with two types by the adjacency to the existing technological trajectory: exploitative innovation and explorative innovation. Exploitative innovation refers to small changes in existing technological trajectory, enhancing firms existing technical capabilities, whereas explorative innovation brings about redirection of technological trajectory and creation of new organizational competencies (Dosi, 1982; Green et al., 1995). It is generally asserted that both efficiency oriented operation and all types of innovation need to be pursued simultaneously for firms' long term survival. On business unit and individual level, when individuals divide time between operational activities and innovative activities, previous literature did not specify the distinct role of operational activities in the pursuit of work flow efficiency, and the tension between exploitation and exploration lacks consideration of operational efficiency in work flows. Different from prior understanding of exploitation and exploration tensions, it was argued that micro-level business unit in achieving ambidexterity needs to consider three distinct elements: the efficiency oriented operational efficiency, the improvement oriented exploitive innovation and the adaptation oriented explorative innovation.

Research on operational process management has traditionally been focused on reduction of process variability and improvement of process efficiency (Benner and Tushman, 2003). Industrial services organizations has reported variability in business work flow such as manufactured machine downtime, batching, hot lots, rework, setup and operator availability (Jacobs et al., 2003). A major source of process variability is lack of standardized practices and procedural information (Locher, 2007). Such variability is seen as negative towards operational efficiency because they are often triggered by problems in the work flow and require additional attentions and time to solve the causes of instability, both in processes and products. In ambidextrous context, innovative activities by nature are also interruptive towards operational process as they are both cognitively and procedurally distinctive from operation activities yet they have to be implemented for adaptation purposes. Swart and Kinnie (2007) treat such distinction as efficiency enhancing and variability increasing activities. The attention and time divided towards innovation following such logic can be seen as a particular type of variability in the context of ambidextrous organizations and business units.

On the micro-level ambidexterity analysis, the relations between repetitive operation and different types of innovation do not receive clarification. Such gap in literature was addressed by conceptualizing micro-level ambidexterity into two categories: operation-exploitation and operation-exploration ambidexterity. When individuals in the business unit divide time between operational and innovative activities in recurrence in the long run, the mixed process can be seen as a queuing process. The micro-level ambidexterity requires operational process share time and attention, which would create process variability that harms the process efficiency. Thus, we argue achieving micro-level ambidexterity needs to manage the variable and uncertain nature of such mixed process.

Adler et al. (1999) detailed illustration of how a Toyota manufacture venture in the vehicle industry can serve as an example to image such settings in the ambidexterity practice. In pursuing both operational efficiency and innovative flexibility, the company in Adler et al. (1999)'s case study adopts two major types of innovation, the Kaizen and the major changeover operation. Kaizen represents an orientation of continuous improvement (that is, exploitative innovation), and major product model changeover represents the substantial change both in product and in manufacturing system (that is, explorative innovation). These two types of innovation were driven by contextual set up on both organizational level and individual level. The Kaizen is conducted by all individual employees in the process of daily operation; whereas major model changeovers are conducted by a pilot team consisting of engineers, managers and employees working in the production systems. In the case of major changeover, ordinary employees need to rotate back and forth from repetitive operation to pilot team and participate in explorative innovation. The case study reports that such a series of methods were in place to make sure the company goes smoothly through efficiency oriented operation as well as both types of innovation.

As organizations require individual ambidexterity to maintain both short term profitability and long term adaptation (Gibson and Birkinshaw, 2004; Tushman and O'Reilly, 1996), individual employees, as in the case study, need to balance between operational efficiency and certain amount of time and attention to both types of innovation. It was argued that different process variabilities induced by different types of innovation impact operational efficiency with different magnitudes. When individuals in a business unit need to divide time between operational activities and exploitive activities, the operational efficiency is negatively impacted with smaller magnitude, whereas when time division is between operational activities and explorative activities, the operational efficiency is negatively impacted with larger magnitude. It was also noticed that when individuals control the time division with certain rhythms or frequencies, the negative impact on operational process can be optimized for higher operational efficiency.

Contribution was made to the current literature by proposing an undervalued process perspective to the current ambidexterity antecedent-outcome debate (Adler et al., 1999; Gibson and Birkinshaw, 2004). By combining the findings in operational and group process literature, operation and innovation were integrated into a singular process model that captures the tension between operation and different types of innovation. A stochastic queuing model proposed by Kingman (1961) to delineate such process was adopted. Our finding on how to arrange time division between operation and innovation may further the current theoretical development on ambidexterity and provide practical implications for managers to achieve ambidexterity in a more operational and individual level.

NUMERICAL ANALYSIS BASED ON QUEUING MODEL

Analysis framework based on group process

Business operation and innovation are usually the result of group working process. Marks et al. (2001) illustrate group working processes help organizations to improve routine works such as select train and develop effective teamwork. Marks et al. (2001) define team process as: "members' interdependent acts that convert inputs to outcomes through cognitive, verbal, and behavioral activities directed toward organizing taskwork to achieve collective goals" (2001: 357). Increased attention on group process rises from organizational research to incorporate new models accounting for group-organizational effectiveness, within which group processes are playing a very important role (Hackman, 1983; Guzzo and Shea, 1992; Gist et al., 1987). Prior literature on group process has extensively explored the usage of an input-process-outcome (I-P-O) framework. Groups are subjected to complex task work or even multitasked in today's organization environment. McGrath (1991) argues that today's working groups within a firm environment often have to manage simultaneously multiple lines of tasks. He asserted that one important aspect of such management skill is the temporal sequence tasks with attention to the task complexity. Marks et al. (2001) also shares McGrath's understanding that multi-tasking is an essential condition associating with group processes; thus, several tasks are often being executed within the same range of time. Multi-tasking creates an environment where members engage in complex sequences of interdependent tasks comprising a larger project (McGrath, 1991: 149). Such dynamic tasking of group process would stimulate group members to constantly involve in optimizing their group process both on a group level as well as on an individual level. Kozlowski et al. (1999) later mention that cycling of group process with multiple goals has contributed to the development of group level learning skills, and that the group process is carried out with multi-stage setting and within intervals of these stages, there are often phases of group developments that helps working groups to rearrange and improve task execution. Marks et al. (2001) developed an I-P-O group process model based on episodic recurrence of group task work. They differentiated group process focuses into two broad directions, one is those that focus directly on goal accomplishment and other group members reevaluate their performances and dwell on future actions. These phases of focus differentiation are categorized into "action" and "transition phases". The interplaying and reoccurrence pattern of group process focuses exhibit substantial resemblance to organizations carrying out exploration-exploitation activities that competes for organizational resources, focuses and routines. The team process may innately require individuals within a group, while achieving certain goals, to leave room for exploitative innovation of process efficiency and explorative innovation for strategic flexibilities. Such a view was adopted to utilize an I-P-O framework in a group process to illustrate how individuals in a group may divide their time between operational activities and different types of innovative activities.

Viewing innovative activities as interruptive intervals to operation

In our model, as prior literature asserted innovative activities are fundamentally different from operational activities, innovations were treated as interruptions on operation. Research such as Zellmer-Bruhn (2003) that is related to group process and interruption has contended interruptions as a trigger within automatic performance of routines for groups to switch into a conscious process of learning and creating new knowledge. Okhuysen and Eisenhardt (2002) contend interruptions act in group interaction as formal interventions that bring new knowledge to the existing resource base. These interventions facilitate knowledge acquisition, transition and integration by various methods such as simple rules on sharing information among members (Henry, 1995); or Schweiger et al. (1989)'s notion of Devil's Advocacy. Bartunek and Murninghan (1984) propose comprehensive structural methods like Nominal Group Technique, while some other literature mentions decisions making processing for strategic choices (Schwenk and Cosier, 1993; Schweiger and Finger, 1984; Cook and Hammond, 1982) and creation and retention of novel ideas (Diehl and Stroebe, 1987).

Such assertion also indicates that when business unit or individuals engage in both operation and innovation, they have to suffer loss of efficiency in operation, as indicated by operation researches on interruption. Federgruen and Green (1986) note service groups are subject to interruptions that are caused by breakdowns, scheduled off-periods or prioritized customs. Interruptions cause disruptive time-outs within cycling of group processes, which traditionally prior research has viewed as negative to performance of routines (Zellmer-Bruhn, 2003). Andrasik and Heimberg (1982) emphasize controlling and minimizing interruptions. Kirmeyer (1988) indicates interruptions increase working pressure. Perlow (1999) and Cellier and Eyrolle (1992) further link interruptions to coordination disruption, overtime work, and work pressure accentuated by temporal rearrangements, which also often associated increases in processing time and error rates. Such innovative activities are associated with loss of efficiency in operation. Our model wishes to delineate such relation by viewing innovative activities as interruption to operation and see how operation efficiency can be optimized with the consideration of different innovation types.

Stochastic queuing between operational and innovative activities

Our method follows Marks et al. (2001)'s notion to generalize business unit process as an operational task execution-innovation framework. We also followed note that individuals in the business unit as a group perform in temporal cycles of task work activities (Zaheer et al., 1999; Weingart, 1997). Process variability induced by innovation uncertainty using a stochastic setting in innovation time was captured. Flexsim software was used for simulation. Flexsim is an object-oriented software environment used to develop, model, simulate, visualize, and monitor dynamic-flow process activities and systems (Nordgren, 2003). The business group process was assumed to be an M/G/10 stochastic queuing model, which uses sequential processing system. The task arrival input will be an exponential distribution, operation task process time for each individual will be a normal distribution and ten individuals are assumed to be within the processing system (that is, business unit).

Figure 1 shows a recursive cycle of queuing between operational task execution process and innovation that follows Marks et al. (2001)'s I-P-O process.

SIMULATION RESULTS

Table 1 gives a data set of the tem-person business group operational process task output with different settings of innovation frequency and innovation time's variability (standard deviation). For example, $n=1$ indicates an innovation activity will occur after one task is completed, and the mean time of innovation activity is given by $x_1=1$. Under these conditions, the variability of an innovation activity is given by $\sigma=1,2,...,8$. The corresponding operational process outputs respectively reach 44348, 43567, 42673, 41661, 40652, 39603, 38496, and 37420. It can be seen from the first column that as the variability level σ (standard deviation of innovation activity time) increases, the performance suffers from a gradual decrease.

Viewing the entire data set, it can also be seen that the

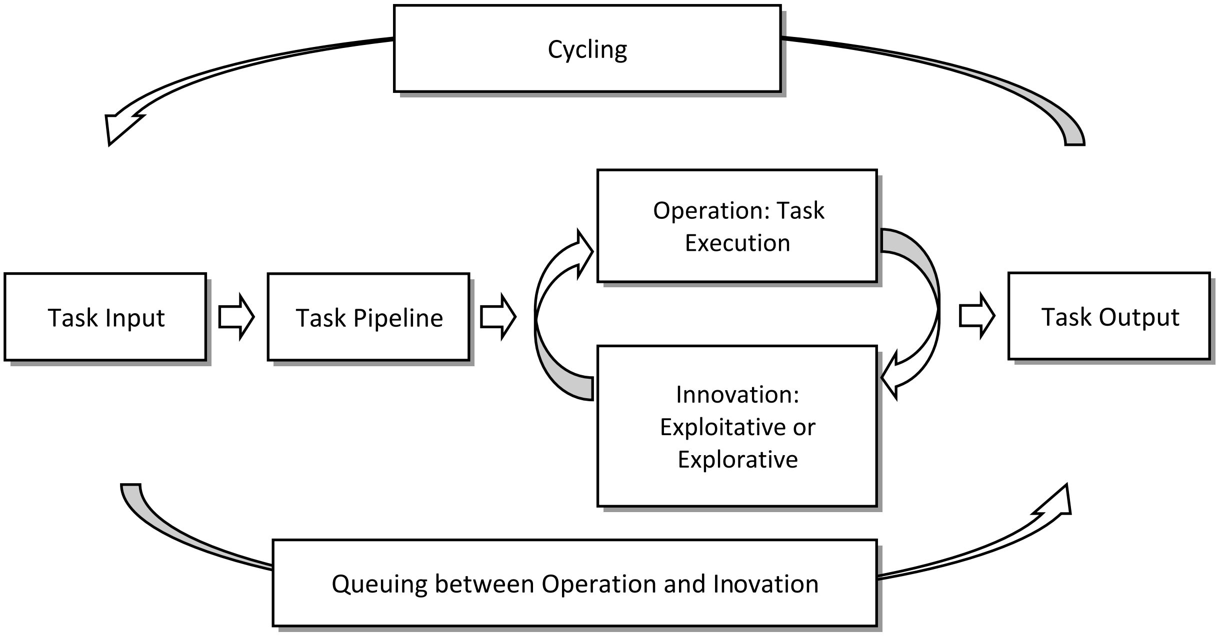

Figure 1. Reoccurring cycling group task and innovation.

Table 1. Simulation productivity levels within one type of innovation activity.

σ	n=1; x_1=1	n=2; x_2=2	n=3; x_3=3	n=4; x_4=4	n=4; x_4=4	n=6; x_6=6
1	44348	44349	44123	43821	43518	43244
2	43567	44017	43946	43736	43497	43165
3	42673	43484	43714	43417	43217	43017
4	41661	42920	43118	43172	43022	42806
5	40652	42036	42617	42668	42619	42480
6	39603	41269	42003	42171	42095	41971
7	38496	40624	41347	41698	41689	41626
8	37420	39764	40650	40994	41056	41106

output performances in each situation, as σ increases, do not decrease with the same speed. The boldfaced numbers indicate a turning points. Between any adjacent situations, N^{th} and $N+1^{th}$, when σ is lower than the turning point, output performance in the N^{th} situation is higher than that of the $N+1^{th}$, but when σ is higher than the turning point, output performance in the N^{th} situation is lower than that of the $N+1^{th}$ condition. For example, between situation $n=2$ and $n=3$, when σ is 1, smaller than 3, the output performance of situation $n=2$, 44349, is higher than that of $n=3$, 44123, and so is the case when σ reaches 2. When σ reaches 3 or larger, the output performance of situation $n=2$, 43484, is lower than that of $n=3$, 43714. Between $n=1$ and $n=2$, the turning point is at $\sigma=1$; between $n=2$ and $n=3$, $\sigma=3$; between $n=3$ and $n=4$, $\sigma=4$; between $n=4$ and $n=5$, $\sigma=8$; between $n=5$ and $n=6$, $\sigma=8$. Figure 2 shows a complete output performance landscape of this data set. The turning points are illustrated as the intersections between any two lines.

We expanded the data horizon to see all 50 situations and corresponding turning points. Table 2 is a summary of turning points of 50 situations. Although performance turning points is applicable to all the situations, but the locations of all the turning points do not appear in an aligned fashion. As the n increases, the location of turning points as marked by σ starts fluctuating.

Figure 3 shows an illustration of all 50 turning points of 50 situations. The turning points' location varies as n increases. A trend line of these locations as marked by n and σ is given by $y=0.9569x+6.3796$, with

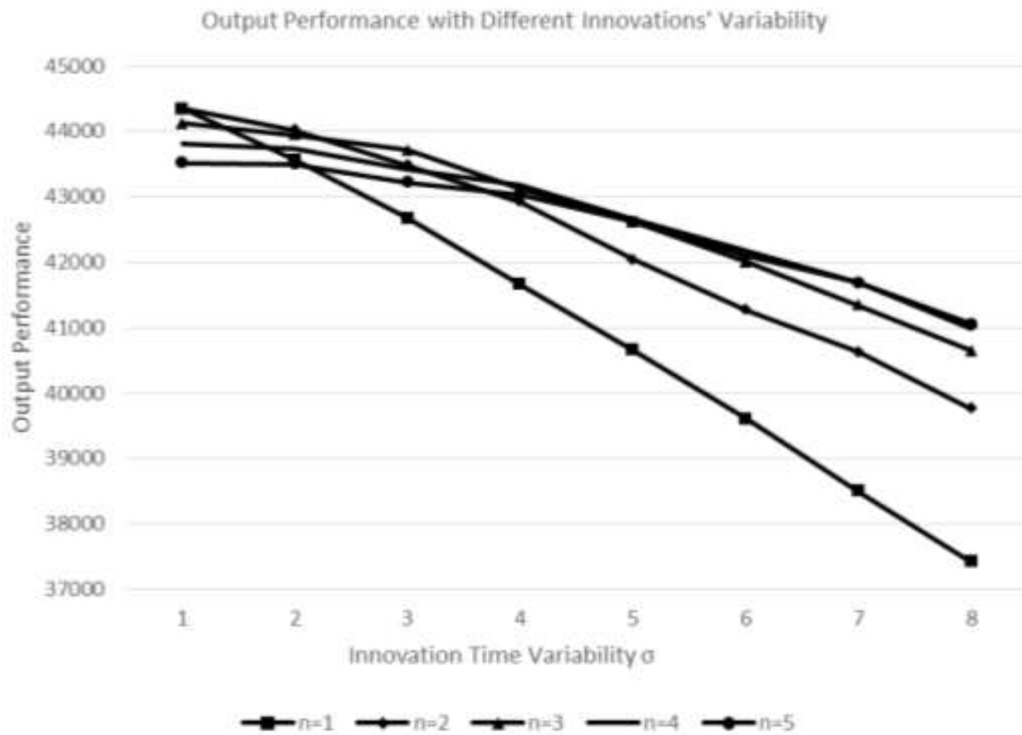

Figure 2. Output performance with different innovation activities.

Table 2. Turning points of 50 situations.

n	σ	Performance	n	σ	Performance
1	1	44349	26	39	32967
2	3	43714	27	38	33180
3	4	43172	28	42	32609
4	8	41056	29	38	33128
5	8	41106	30	38	33232
6	13	39123	31	34	33760
7	13	39138	32	42	32852
8	14	38136	33	27	34375
9	18	38136	34	45	32599
10	16	37166	35	37	33516
11	20	35580	36	45	32943
12	18	36438	37	37	33592
13	23	34922	38	42	33032
14	26	34069	39	57	31914
15	19	36080	40	54	32273
16	23	35099	41	35	33657
17	24	34873	42	35	33747
18	22	35287	43	40	33396
19	17	36126	44	42	33075
20	27	34419	45	41	33304
21	36	32809	46	46	32947
22	29	34073	47	51	32761
23	29	34083	48	56	32442
24	27	34359	49	49	32827
25	23	35011	50	67	31824

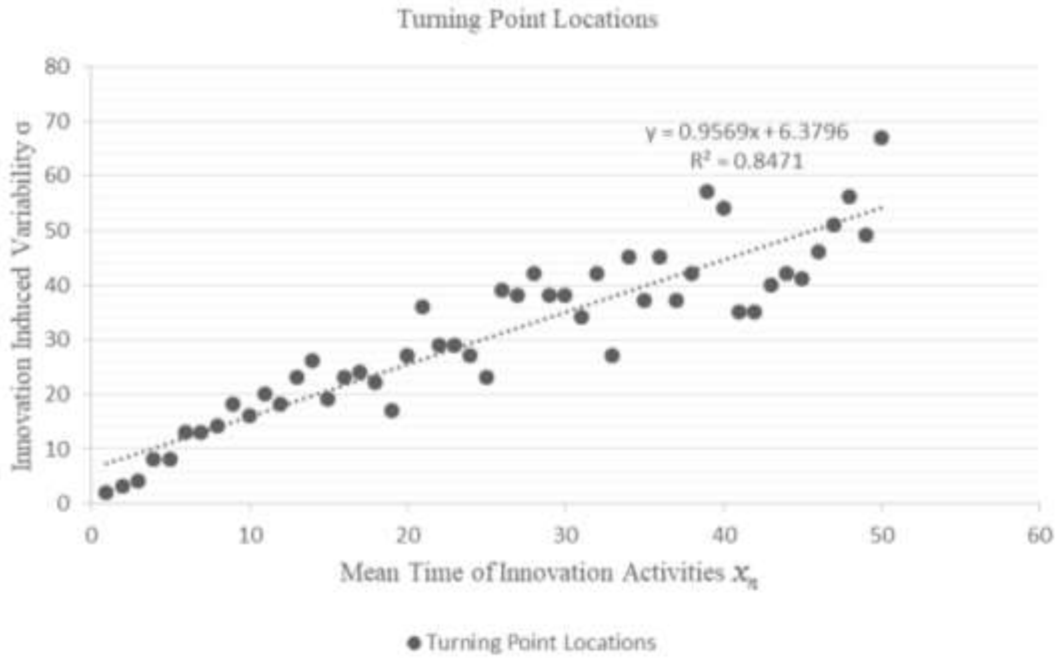

Figure 3. Turning points locations of 50 situations.

$R^2 = 0.8471$. This result indicates that the performance of operational process can be optimized by increasing or decreasing n linearly according to σ changes.

From Table 2 and Figure 3, it can be seen that the optimal efficiency occurs when frequency of innovative activities are matched with their variability linearly. The implication of this result is that balancing exploitation and exploration on a group level requires attention to different learning types of innovation. For those explorative activities that has high variability in time requirement, it is best that these activities are carried out with lower frequencies; whereas for those exploitive innovative activities that has lower variability in time requirement, output can be optimal when innovative activities are carried out with higher frequencies. This result also implicates that optimal efficiency does not restrain innovative activities with fixed speeds, as the managers can accelerate or decelerate innovative activities with an attention to their variability changes.

DISCUSSION AND MANAGERIAL IMPLICATION

Previous literature on how to achieve ambidexterity has primarily focused on the structural and organizational level antecedents and outcomes. Although rich debates have generated various methods to achieve organizational ambidexterity, empirical studies have reported mixed findings on ambidexterity-performance links. On the other hand, ambidexterity at the micro-level has been underexplored as the focus of previous studies has been on organizational implications (Junni et al., 2013; Mom et al., 2009; Lavie et al., 2010; Raisch and Birkinshaw, 2008). This paper attempts to provide a process view into the discussion of ambidexterity antecedents and outcomes and further the understanding on why organizational ambidexterity may or may not help organizations to achieve superior performance.

It was argued that on business unit and individual level, how individuals' time is divided between operational and innovative activities can also be counted a crucial antecedent that contributes to the complex relationship between organizational ambidexterity and performance. In an ambidextrous business unit, individuals' operational process is intervened by innovative activities. The operational efficiency will be negatively impacted by such time division. The process variability induced by innovation uncertainties will also contribute to such impacts.

Further, ambidexterity literature asserts that micro-level ambidexterity requires business unit and individuals in an organizations not only optimizing operational efficiency but also conducting both exploitative and explorative innovations. It was argued that two types of innovation impose different level of variability to operational process. Specifically, when individuals in a business unit as a group needs to intervene operational process with exploitive innovation, the operational efficiency and performance overtime will be impacted by time division and process variability with smaller magnitude whereas when operational process is intervened by explorative innovation, the negative impact from time division and process variability is larger.

As individuals in a business unit have to cyclically divide time between operation and innovation, we adopt an Input-Output group process model and a stochastic queuing system to simulate such process. Our findings indicate that operational efficiency can be negatively impacted by time division and process variability induced by innovative activities, and different level of variability has different impact on operational efficiency. However, another key finding of our research indicates that controlling frequency of innovation activities can help alleviate the negative impact from process variability. Specifically, when individuals need to divide time between operational activities and exploitive innovation with low process variability, high frequency is preferable for optimizing operational efficiency. When individuals need to divide time between operational activities and explorative innovation with high process variability, low frequency is preferable for optimizing operational efficiency.

Our research findings have implications in several ways: first, managers not only need to pay attentions to structural or contextual antecedents and associated performances, the micro-level process related antecedent such as operational process variability and time division also requires attention for management. Our research confirms that the process variability induced by dividing time to innovative activities will negatively impact operational efficiency. However, process variability induced by innovation uncertainty cannot be directly reduced since innovations are naturally associated with uncertainty. Second, instead of trading off operation time and efficiency for innovation, managers and individuals in a business group can alleviate such negative impact imposed by innovation by adopting a certain temporal rhythm for conducting innovative activities. Further, as different types of innovation bring about different process variability, adopting different rhythms for conducting different innovative activities can optimize operational efficiency. Innovations with high uncertainties such as explorative innovation, can be associated with infrequent rhythm, and innovations with relatively low level of uncertainties such as exploitive innovation, and can be associated with frequent rhythm. Such arrangement will help organizations to achieve superior performance and at the same time leaving enough time for innovation at business unit and individual level.

Take Adler et al. (1999)'s case study as an example to better illustrate the management implication of our theory. In the case study, individual employees working in the Toyota manufacturing system needs to balance between repetitive operation and two types of innovation (that is, the Kaizen and the pilot team program). Uncontrolled arrangement of time among these three types of activities may negatively impact operational efficiency because the working time needs to be divided into three parts other than focusing all into repetitive operation or manufacturing, which is very likely to result in the less optimal balancing effort of ambidexterity. However, as our simulation indicates, controlling the frequency of dividing time from operation to innovation can result in different level of efficiency. Our simulation shows the key to control such time division is the variability level of innovative activities, in which case we use the standard deviation of the time divided innovation as the indicator of variability level. Our results indicate controlling frequency of innovative activities according to their variability level can help the operational efficiency to reach superior state. Specifically, when individuals need to divide time between repetitive operation and exploitive innovation (such as Kaizen), the frequency of innovative activities should be high. When individuals need to divide time between repetitive operation and explorative innovation (such as rotating into the pilot team to facilitate major model changeover), the frequency of innovative activities should be set much lower considering the variability of such activities.

A more interesting finding from our result is that manager may be able to dynamically maintain high level of operational efficiency and in the same time accelerate or decelerate the frequency of exploitative innovation and explorative innovation. Although our results do not directly indicate when to accelerate or to decelerate innovative activities, they do implicate the best operational efficiency in such ambidextrous case is in a linear relationship with variability level of innovative activities. Such implication may help managers to judge for the timing of appropriate frequency of each type of innovation and the optimal time for acceleration or deceleration. If the variability of innovation is dropping, such as when the employees are becoming experienced in Kaizen or participating pilot team, they are quicker in completing the innovation objective and reach positive result than the past, managers in this case may consider accelerating the innovation pace. Whereas when variability level of innovative activities is raising, such as undertaking innovations that are more distant from current technological trajectory or associated with higher level of uncertainty, managers may need to consider decrease the frequency of employee's engagement in innovative activities. On the other hand, when the external environment requires organizations face acceleration or deceleration environmental change that puts more pressure on organizations to accelerate or decelerate their innovative activities, managers may also be able to adjust their pace according to our theory. To accommodate change in the organization or in a business unit to catch up with environmental change, managers may adopt major measures to reduce variability in the operation-innovation process such as the techniques in Lean management or Six Sigma programs with an arrangement and consideration between innovation and operation. Reduced variability in the operating-innovation combined process can create more space for manager to accelerate innovative activities while maintaining the same level of performance. Our theory in this way can help managers not only make judgment on how to decide the speed or frequency of innovative activities for individuals in a business unit, but also they can help the managers adjust the speed or frequency of innovative activities to optimize the operational performances.

Conclusions

This paper uses a stochastic queuing model to analyze how to achieve ambidexterity to address productivity dilemma on a micro level. A nuanced perspective focusing on organizational process to explain the mixed empirical findings on ambidexterity was provided. Our findings suggest the time division between operation and innovation needs to consider the process variability induced by innovation uncertainty, because these factors prove to be negatively associated with operational efficiency. However, controlling the frequency of innovation can help alleviate such negative impacts. Different types of innovations are associated with different levels of uncertainty, and therefore the different frequency needs to be matched contingently towards different types of innovation. Further, as our result presents a linear link between frequency of innovative activities and innovation variability, managers may also be able to judge the better time for acceleration or deceleration of innovative activities. Our research contributes to the literature with a new perspective to the understanding of antecedents and outcomes for ambidextrous organization and a method to optimize efficiency in micro level ambidexterity. As our research is a simulation base analysis, future researches can empirically test our results. Also, our model does not consider different industries may concern different operational process, different processes associated with different industries may provide more insights to the process view of ambidextrous organization.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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